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ABSTRACT

This instructor's guide on electrical and other major appliance repair is part of a series of individualized instructional materials. The guide is provided to help the instructor make certain that each student gets the most benefit possible from both the student's manual and what he/she does on the job. Notes for the instructor contain suggestions on how the student should use the student's manual. Other contents of the guide include answers to exercise questions and assignment test questions, one set of assignment tests, a progress record, and work sheets that the instructor can use to relate instruction to job experience for the student. Topics covered are occupational outlook; safety; hand tools; power tools; electrical and magnetic fundamentals; controls; electromagnetic fundamentals of alternating current (AC) generators, transformers, and motors; theory and measurement of AC; electrical meters and test equipment; heating and lighting; electric appliances; and gas appliances. (YLB)

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Major Appliance Repairer

D.O.T. 723.381-010
T.E.A. 17.02 00

Instructor's Guide

By
Bill Bacon and Mack Sutton

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Foreword

This publication is one of a series of individualized instructional materials. Students using this material can work at their own pace, enabling them to concentrate on areas that best fit specific needs. The design of the instruction makes it possible to relate work experience with materials studied at school.

Although the material is designed for individualized study, it should be used under the supervision of an instructor. For that reason, two basic publications are offered—a student's manual and an instructor's guide.

The *student's manual* is for the use of the person in training. The assignments in this manual are self-contained. Each assignment has a list of objectives and exercise questions that can help the student meet those objectives.

The *instructor's guide* has additional information that may help the instructor help the student. There are suggestions on how the student should use the student's manual, and how the instructor can coordinate work experience and learning in school. The instructor's guide also contains (1) answers to exercise questions and assignment test questions, (2) one set of assignment tests, (3) a progress record, and (4) work sheets that the instructor can use to relate instruction to job experience for the student.

Although both publications are copyrighted, an instructor should feel free to reproduce copies of the assignment tests, progress record, and work sheets. To make that possible, these have been placed in a separate section of the instructor's guide, where they are accessible for copying. If the instructor prefers, copies of these same sheets can be ordered separately for individual students from Extension Instruction and Materials Center, The University of Texas at Austin, P. O. Box 7218, Austin, Texas 78712.

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and Materials Center

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Notes for the Instructor

The instructor's guide is provided to help the instructor make certain that each student gets the most benefit possible from both the student's manual and what he or she does on the job. To do so, this guide includes the following:

1. notes for the instructor;
2. answers to assignment exercises;
3. answers to assignment test questions;
4. the assignment tests, in the form in which they will be used by the student; and
5. work sheets and a progress record for planning and recording work experiences and the related assignments from the student's manual.

These notes and all answers to exercise and test questions should be kept by the instructor. The assignment tests, progress record, and work sheets may be removed from this guide to be used or reproduced. For convenience, this guide is punched for notebook use.

Occupational Requirements

The contents of the student's manual are related to the occupational titles of electrical appliance repairer, D.O.T. 723.381-010, in the *Dictionary of Occupational Titles* (1977), published by the Department of Labor, and appliance repairer, U.S.O.E. code 17.022.

Assignment Design and Teaching Principles

The student's manual presents related technical information to (1) groups of trade and industrial students with diversified vocational objectives and (2) homogeneous groups in which the learning levels of individual students vary considerably. The student's manual is not intended to be used as a type of correspondence course. Instead, it must be used by students under the direct supervision of an instructor.

Each assignment in the student's manual is designed to use as many fundamental teaching principles as possible. For that reason, each assignment is broken down into four parts—objectives, technical information, exercise, and test.

Objectives. The first teaching principle is that the student should be informed at the outset what he or she should learn from an assignment. This is done through a list of objectives for each assignment. These are performance objectives that can be tested when the assignment is completed.

Technical Information. The second teaching principle is that technical information should be presented in a complete but concise form. All the information needed to complete the assignment exercise and meet the objectives is found in the assignment itself. This information has been organized to help the student learn more easily—either step by step, moving from simple to complex, or by logical topics and subtopics.

Exercise. The third teaching principle is that technical information is learned better if it is applied as soon as possible after it is presented. This is done by using an exercise for each assignment. The exercise questions are phrased to emphasize key points and to aid in evaluating the technical information. The instructor should impress on students that both the objectives and the technical information should be read before they attempt to answer the questions in the exercise. An exercise is not an open-book test, and this idea should be discouraged. Answers may be useful in helping a student who is having difficulty with an assignment exercise.

Test. The fourth major teaching principle is that the effectiveness of an assignment should be evaluated. This is made possible by brief assignment tests provided in this instructor's guide. A test should be given when an assignment is completed. Each test is based on the objectives stated for that assignment.

The answers to both assignment exercises and assignment tests have been made as brief as possible to make it easier for the instructor to check the student's classroom work quickly and accurately. All answers should be retained by the instructor for obvious reasons.

Tests, Progress Record, and Work Sheets

The last section of this instructor's guide contains the tests, a progress record, and work sheets, which can be removed for reproduction or other uses. The instructor may reproduce these without the publisher's permission. Sets of the material in this section can also be ordered separately.

The progress record and work sheets are provided for the convenience of the instructor in keeping track of a student's progress in jobs and in assignments.

Answers to Exercises

Exercise A-1

Using This Manual

---

1. technical instructions, procedures, and illustrations
2. the combination of classroom study and the actual work on the job
3. (1) objectives
   (2) information
   (3) exercise
   (4) test
4. before reading the information part of the assignment
5. The student should read the information and study the illustrations.
6. tools and materials, as well as certain procedures and operations
7. when answering the exercise questions or when certain tasks on the job make it necessary
8. to help the student meet the objectives
9. in the form of complete sentences
10. The student should correct any mistakes and place the papers in his or her notebook.
11. when the exercise questions have been answered correctly
12. make the student think
13. A test may be given as soon as an assignment is completed, or several tests may be combined as a weekly or six-weeks' test.
14. fill-in-the-blank and multiple-choice

Exercise A-2

Occupational Outlook for Appliance Repairers

---

1. good working conditions in the shop and working with little or no supervision
2. working in narrow spaces in uncomfortable positions, in dirty and dusty places, and long hours spent driving
3. the International Brotherhood of Electrical Workers
4. through on-the-job training
5. customers' homes
6. by examining it, checking it, and operating it
7. (1) portable appliances
   (2) major appliances
8. in independent appliance stores and repair shops
9. an increase in demand for qualified repairers

Exercise B-1

General Hand Tool Safety

1. Even a small splinter can cause infection, tetanus, or gangrene.
2. an accident caused by the tool flying off of the handle
3. Handles give more control and prevent the tangs from causing injury.
4. Serious injury could result to your hands if the drill bit should hang.
5. See that all joints are taped, that the shells of all sockets are connected to the neutral or grounded conductor, and that all wiring is kept out of reach of people in damp areas.
6. Flying pieces of metal could cause injury.
7. to keep control of the tool and to avoid an accident if either person slips
8. metal rules or measuring tapes and screwdrivers with metal handles
9. Injury could be caused by flying pieces of metal.
10. Wear goggles, and don't allow anyone in front of the wheel.
11. because you may break your fingers, skin your knuckles, or fall

Exercise B-2

Working Safely with Electrical Equipment

1. Wet skin conducts electricity much better than does dry skin
2. They should be tested electrically.
3. a fuse puller
4. (1) Have someone with you.
   (2) Stand on a dry rubber mat.
   (3) Touch only one conductor at a time.
5. so that the capacitor will discharge, preventing a dangerous shock
6. (1) sleeves rolled up
   (2) hands free
   (3) no loose clothing
7. The gloves are not designed for working with such voltages.
8. to prevent the transformer from destroying itself
9. An arc or flash may result in burns or damage to the eyes.
10. Be sure that no one is in a position to be injured when the equipment operates or that no one is working on the equipment.

Exercise B-3

First Aid for Electrical Shock

---

1. until all hope is gone
2. Listen for the rush of air through the victim's mouth after you have breathed in.
3. to open the airway
4. (1) using commercial attachments
   (2) blowing through a clean cloth placed over the victim's mouth and nose
5. He or she should be kept quiet, warm, and lying down. Keep a close check on the breathing.
6. (1) carelessness
   (2) misuse of electrical equipment
   (3) faulty wiring or equipment
   (4) improper installations
7. (1) Place a nonconductor around the victim and separate him or her from the conductor.
   (2) Shut off the power.
   (3) Use the clothes of the victim to remove him/her if the voltage is not too high.
   (4) Cut the conductor between the victim and the power source with a pair of insulated cutters.
   (5) Use a piece of dry wood to separate the victim from the conductor.
8. Check the mouth for foreign matter and to make sure the victim has not swallowed her or his tongue.
9. Watch closely to make sure the victim does not swallow his/her tongue.
10. Recheck the head and jaw positions. If this does not help, then give several sharp blows between the victim's shoulder blades, and sweep your fingers through the mouth again to remove any foreign matter.

Exercise B-4

First Aid for Accidental Injuries

---

1. a serious infection
2. Apply an antiseptic and a sterile bandage.
3. only if bleeding cannot be controlled by other means
4. (1) first degree—red skin
   (2) second degree—blisters
   (3) third degree—deep tissue destruction
5. Use splints and keep the fracture at rest.

6. (1) serious bleeding
   (2) stoppage of breathing
   (3) shock
   (4) burns
   (5) fractures
   (6) minor wounds and injuries
7. cold and clammy skin; wide, staring eyes; weak and rapid pulse; irregular breathing; sweating; severe chills; nausea and vomiting
8. to prevent further injury from falling objects or debris
9. The history of the injury should be given.
10. Apply a sterile dressing and then splints. Keep the fracture at rest, and control any bleeding.

Exercise C-1

Cutting and Driving Tools

---

1. (1) straight-cutting
   (2) right-hand
   (3) left-hand
2. The upper blade is on the right for left-hand curves and on the left for right-hand curves
3. from the cutting edge of the blade to the back of the frame
4. a handle
5. the mill file
6. a file card or brush
7. the twist drill bit
8. (1) numbers
   (2) letters
   (3) fractional inch
   (4) metric system
9. a metal plate with holes of different sizes, corresponding to the different drill sizes
10. It has a cylindrical face and a peen or claw opposite the face.
11. to flatten the ends of rivets or shape metals
12. during installation operations
13. to pound or drive objects or do other jobs where a steel hammer would mar or break the work
14. according to the type of tip
15. the standard and the Phillips
16. according to the length from the blade tip to the handle
17. by its square shank

Exercise C-2

Pliers, Wrenches, Vises, and Clamps

---

1. pliers
2. The jaws can be opened to a wider position for gripping larger diameters.
3. to cut electrical wire
4. as nonadjustable or adjustable
5. 150°
6. twelve
7. combination wrenches or half-and-half wrenches
8. socket wrench
9. the number of teeth or points on the ratchet
10. an adjustable wrench
11. File it so that the proper size of wrench will fit.
12. a machinist's vise
13. C-clamp
14. spring clamp

Exercise D-1

Portable Drills

---

1. ¼-inch or ½-inch drill
2. (1) precision ball bearings
   (2) oilless bronze bearings
3. to keep the drill from twisting in the operator's hands
4. (1) geared chuck
   (2) hex key chuck
   (3) hand-tightening chuck
5. a bench holder attachment or drill stand
6. because the hole will be larger than desired
7. a prick punch or awl
8. Do not force it.
9. goggles
10. They help absorb pressure from the tightening nut and prevent the wheel from cracking.
11. Blow away shavings and dust, wipe off oil and grease, secure the cord, and store in a dry, safe place.

Exercise D-2
Drill Presses

1. by changing the belt on the pulleys
2. It is twice the distance from the center of the chuck to the column.
3. to raise or lower the spindle
4. the depth gauge
5. the key
6. directly below the center of the drill
7. when large drills are being used and when metal is being drilled
8. It may be caught by the drill and spun, causing serious injuries.
9. Reduce the feed pressure.
10. to prevent the table and column from rusting
11. Unplug the electrical cord.

Exercise D-3
Grinders

1. the horizontal spindle type
2. (1) bond
   (2) abrasives
3. vitrified bond
4. silicate bond
5. Place a metal rod through the center of the wheel, and tap the side with wood. A clear ring indicates the wheel is sound.
6. exerting too much pressure when tightening the nut
7. flanges
8. It must be dressed.
9. (1) mechanical dresser
   (2) abrasive stick
   (3) diamond dresser
10. small or light cuts
11. sharpening tools
12. It causes undue wear on the abrasive materials. It may also slow the grinder, burn the tool, and break or groove the wheel.
13. dampness or extreme temperatures
14. at least one-third the wheel diameter
15. goggles or safety glasses

Exercise E-1
Magnetism

---

1. A *natural* magnet is an unrefined product of nature.
2. An *artificial* magnet is a magnet made from iron or steel by artificial means.
3. the north pole
4. A magnetic substance is one that can be attracted by a magnet.
5. Iron, steel, cobalt, nickel, and manganese are *magnetic substances*. Air, wood, paper, glass, copper, aluminum, lead, tin, and silver are *nonmagnetic substances*.
6. *Retentivity* is the ability of a material to retain its magnetism after the magnetizing force has been removed.
7. Like poles repel one another.
8. Unlike poles attract one another.
9. Soft iron rapidly loses its magnetism after being removed from a magnetic field.
10. one pair of poles (north and south)
11. The amount of magnetism retained by a material after the magnetizing force has been removed is called *residual magnetism*.
12. There is no known insulator against magnetic lines of force.
13. The intensity of the magnetic field between the magnets decreases very rapidly as the distance between the magnets increases.

Exercise E-2
Electricity

---

1. (1) positive
   (2) negative
2. Two negative charges repel each other, and two positive charges repel each other, but a positive and a negative charge attract each other. In other words, like charges repel each other, and unlike charges attract each other.
3. Electrical force does not attract magnetic substances.
4. It means that all substances can be *electrified*, or charged with electricity.
5. A molecule is the smallest particle of matter that can exist by itself and still retain all the properties of the original substance.
6. An atom is the smallest part of an element that can take part in ordinary chemical changes.
7. electrons, protons, and neutrons
8. the charge on the electron
9. the electrons in the outer shell, the valence shell

10. Elements that have only one valence electron—such as gold, silver, and copper—are the best electrical conductors because less energy is required to move the electron out of its orbit.
11. When a conducting path is provided between a charged material and a neutral material, electrons will flow (current electricity) from one material into the other until the electric charge between the materials is near zero.
12. The force that causes electrons to flow is called electromotive force (emf).

Exercise E-3
Electromagnetism

---

1. The compass needle will turn at right angles to the conductor.
2. The compass needle would swing at right angles to the conductor in the opposite direction.
3. If a coil is wound on a core of magnetic material, it is an electromagnet.
4. A solenoid is a coil of wire that has considerable length as compared with its diameter. While current is flowing, a solenoid has the properties of a permanent magnet.
5. Soft iron or soft steel generally is used because the retentivity of those materials is so low that they retain very little residual magnetism when the current stops flowing.
6. in electronic equipment, including relays, motors, generators, radios, and transformers
7. a force known as the magnetomotive force (mmf)
8. A moving electric field creates a magnetic field, and a moving magnetic field creates an electric field.
9. The total energy of a moving charge is the sum of the energy in its electric and magnetic fields.

Exercise E-4
Units of Electrical Measurement

---

1. resistance
2. in volts
3. Watt's law
4. negative
5. amperes
6. ohms
7. $P = IE$
8. $E = P/I$
9. $I = P/E$
10. efficiency = output/input $\times$ 100 = percentage of efficiency

Exercise F-1

Switches

---

1. Switches must start and stop electricity from flowing in each circuit.
2. Only one wire is connected or disconnected by the switch.
3. A single-pole, double-throw switch is used to select a high or low heat in a heater circuit, or in a two-speed motor circuit.
4. When you check the continuity across a switch, it would look like an open circuit when it is off and a short circuit when it is on.
5. a rotary switch with two conductors
6. It costs much less to buy a new switch than to repair one.

Exercise F-2

Timers and Solenoids

---

1. an electric clock motor that runs at a constant speed
2. a pair of switch contacts that are welded shut from arcing
3. Carefully pry them apart, and clean them with sandpaper.
4. a coil and a soft iron bar
5. It can shift gears, tighten a belt drive, open or close a valve, start or stop an agitator in a washer, or perform almost any mechanical function.
6. a solenoid that controls a high current or voltage
7. an open coil or a grounded coil
8. Make a continuity test at its terminals.

Exercise G-1

The Generation of Alternating Current

---

1. the generator
2. (1) the number of turns in the conductor
   (2) the strength of the magnetic field
   (3) the speed of the relative motion between the conductor and the magnetic field

3. *Alternating current* is defined as a current that is constantly changing in magnitude and periodically changing direction.
4. The magnetic field is established between the north and south poles of the stator (stationary part) by exciting the windings on its core with direct current.
5. A multipolar generator is one that has more than a single pair of poles.
6. The *frequency* of an alternating current is defined as the number of electrical cycles per second or the number of times per second that a sine wave (360 degrees) of current occurs.
7. The frequency of the voltage is 60 cyles per second.
8. Electrical meters are calibrated to read effective values.
9. It could be any phase. The number of poles has nothing to do with the generated phase.
10. The field coils are wound on the rotor, and a magnetic field is set up between corresponding poles by a direct current. This magnetic field rotates with the rotor as it is turned.
11. *Phase difference* is the difference in time between any two cycles.

Exercise G-2

Transformers

---

1. A *transformer* is a device by which the voltage of an AC system may be changed. It can also be defined as a device that transfers power from its primary circuit to its secondary circuit without loss.
2. The coil connected to the source of power is the primary winding. The coil connected to the load is the secondary winding.
3. The connection between the coil windings of a transformer is the flux linkage of the magnetic circuit, which produces high mutual inductance.
4. This is done to prevent eddy currents. It also prevents, to a large extent, the heating of the core.
5. A *step-up* transformer has more turns in the secondary coil than in the primary coil. A *step-down* transformer has fewer turns in the secondary than in the primary.
6. Autotransformers are used in some motor control circuits to provide reduced voltage starting of large AC motors.
7. The power in the primary circuit is always equal to the power in the secondary circuit.

Exercise G-3

Theory of Electric Motors

---

1. The purpose of the generator is to change mechanical energy into electrical energy. The purpose of the electric motor is to change electrical energy into mechanical energy.
2. It is the reaction between the two magnetic fields—the magnetic flux created in the armature and the magnetic flux of the field poles—that causes the armature of the electric motor to rotate.
3. The torque, or turning force, exerted in a magnetic field is proportional to the strength of the magnetic field, the length of the field and number of turns in the conductor, and the strength of the current flowing in the conductor.
4. The back emf is in the opposite direction to the applied emf, which causes the motor to run.
5. As the motor speed increases, the back emf increases, until it is almost equal to the applied emf.
6. At the instant the motor starts, when the back emf is zero, a large current, called *inrush current*, rushes through the motor windings.
7. It depends on a revolving, or rotating, magnetic field to produce torque.
8. The rotor of an induction motor consists of an iron core having longitudinal slots around its circumference in which heavy copper or aluminum bars are embedded. These bars are welded to a heavy ring of high conductivity on either end.
9. The difference in speed between the rotor and the rotating field is called *slip* and is expressed as a percentage of the synchronous speed.
10. A multiphase source of alternating current is applied to the stator windings, and a rotating magnetic field is produced. A direct current is applied to the rotor windings, and another magnetic field is produced. The synchronous motor is so designed that these two fields react on each other in such a way that the rotor is dragged along and rotates at the same speed as the rotating magnetic field produced by the stator windings.

Exercise H-1

Inductance and Its Reactance to Alternating Current

---

1. A *henry* is defined as the inductance of a circuit in which a current change of 1 ampere per second causes a counter emf of 1 volt.
2. $L_T = L_1 + L_2$
3. $L = \dfrac{1}{1/L_1 + 1/L_2 + 1/L_3}$
4. $X_L = 2\pi fL$
5. The current and voltage are in phase with one another.

Exercise H-2

Capacitance and Its Reactance to Alternating Current

---

1. the farad (C)
2. the microfarad
3. the dielectric
4. (1) area of plates
   (2) distance between plates
   (3) dielectric materials
5. its dielectric strength
6. A *farad* is defined as the capacitance of a circuit or capacitor that will permit one amp of current to flow when there is a change of one volt per second.
7. $C_T = C_1 + C_2$
8. Large capacitors may hold a lethal charge that could injure or kill.
9. Capacitive reactance (X_C) is the opposition of alternating voltage. It is that property that opposes any change in the magnitude of voltage.
10. $X_C = \frac{1}{2}\pi fC$
11. Capacitive reactance opposes changes in voltage, which causes the current to lead the voltage in time.

Exercise H-3

Alternating-Current Principles

---

1. Impedance is the total opposition of the resistance and reactance elements to the voltage and current in AC circuits. The symbol Z is used to represent impedance.
2. ohms
3. They are 90 degrees out of phase with each other.
4. Power factor is the ratio of true power (useful power) to apparent power (power delivered).
5. True power is measured with a wattmeter, in watts or kilowatts. Apparent power is the product of the readings of a voltmeter and an ammeter (P = IE) and is measured in volt-amperes or kilovolt-amperes.
6. Wattless power is the power delivered to the circuitry that cannot be used because of low power factor due to the out-of-phase condition of the current and voltage.
7. The two types of reactance are 180 degrees out of phase with one another. They are the same as opposite polarities.
8. Low power factor means that a low percentage of the power delivered is used by the circuitry because of reactive elements that cause the voltage and current to be out of phase with one another.
9. Since they are 90 degrees out of phase with one another, they must be combined vectorially.

Exercise I-1

Measuring and Test Equipment

1. in parallel
2. in series
3. Your body resistance may cause a serious measurement error.
4. by connecting a high-resistance multiplier in series with the meter movement
5. from the circuit, and all capacitors discharged
6. on the largest range
7. the current passing through its coil
8. One field is supplied by a permanent magnet and the other by a moving coil.

Exercise J-1

Heating Effects

1. (1) resistance
   (2) induction
   (3) dielectric
2. high-resistance wire
3. by conduction, convection, and radiation
4. inducted eddy currents
5. a unit of work equal to one watt-second
6. by kilowatt-hours
7. calories or Btu
8. 252 calories
9. the time, the resistance, and the square of the current
10. the strength of the field, the rate at which the field changes, the specific resistance of the metal being heated, the area of the metal, and its position with respect to the magnetic field

Exercise J-2

Lighting Effects

1. the incandescent lamp
2. the fluorescent lamp
3. the germicidal tube
4. the panelescent lamp

5. the low cost of bulbs
6. Most of the electricity consumed is changed into heat instead of light.
7. extremely long life
8. The amount of electricity converted into light is extremely high.

Exercise J-3

Incandescent Lighting

---

1. the incandescent lamp
2. the percentage of light reflected from a surface
3. candlepower
4. diffusing (reflecting) the light
5. miniature, candelabra, medium, admedium, mogul, and three-way light
6. with a light meter
7. the lumen
8. by frosting the inside of the bulb
9. 26 lumens per watt

Exercise J-4

Fluorescent Lighting

---

1. a high-voltage arc striking between cold cathodes
2. manual, glo-switch, and thermal
3. operating conditions
4. a resistive element that is heated by current flow
5. to glow when exposed to ultraviolet light
6. to eliminate flicker and to produce a surge in starting voltage
7. in excess of 16,000 hours
8. one candlepower at one foot
9. at less than 40 percent of the cost
10. by adding resistance to the ballast in order to limit the operating current to the designed value
11. a glow-lamp in which one of the electrodes is a bimetallic, thermostatic blade
12. They produce light by passing a current through a gas vapor under pressure.
13. the average light output after 100 hours of operation

Exercise K-1

Electric Ranges

---

1. (1) wire-coil type
   (2) tubular units
2. the number and size of the wire coils, which set up an ohmic resistance to the electrical current
3. by means of a bimetal switch
4. Its own internal heat causes it to cycle on and off.
5. a broil unit at the top of the oven made up of two coils and a bake unit at the bottom with one coil
6. (1) a selector switch
   (2) a thermostat
7. The oven thermostat uses a bulb-and-bellows-type thermostat filled with a liquid. When heated, the liquid expands and pushes open the bellows, which opens a pair of electrical contacts.
8. A series of terminals opens and closes the appropriate circuits to surface units, ovens, or appliance outlets, as selected by the user. It is powered by a synchronous motor.
9. to eliminate the nuisance of blown branch line fuses caused by turning on all the units on *high*
10. when the force of a magnetic field created by a current exceeds the holding power of a spring-loaded mechanism

Exercise K-2

Electric Clothes Washers

---

1. (1) automatic type
   (2) conventional type
2. A pressure switch or a float switch is preset to open when the proper level is reached. The operation is done by means of solenoids.
3. by either a gear train or clutch arrangement
4. sector gear, connector rod, or rack and pinion gear
5. A cam surface on the timer-motor cam assembly closes another switch, energizing a solenoid valve to open and drain the tub.
6. (1) The *mechanical system* includes the main-drive motor, the gear train, and the basket-drive and brake assembly.
   (2) The *water system* consists of a series of valves, a water pump, and various accessories such as dispensers, filters, and hoses.
   (3) The *electrical system* consists of a 110-volt, 60-hertz drive motor, a timer motor, and various electrical components used to control the flow of water.
7. by a V-belt riding on a drive pulley

8. The whole mechanism springs open when a bulky, unyielding object tries to go through the rollers.
9. by the discharge impeller of the water pump
10. (1) single solenoid shut-off valve
    (2) double solenoid shut-off valve
    (3) triple solenoid shut-off valve
11. to stop the spinning when the door is opened, by interrupting the power to the basket-drive assembly and applying the stop brake

Exercise K-3

Electric Dishwashers

---

1. (1) impeller dishwasher
   (2) spray-arm dishwasher
2. It advances a series of cams, whose raised surfaces open and close circuits in sequence in the course of their slow rotation.
3. A typical fill cycle lasts about 60 seconds and admits about 12 pints of water, flowing at a rate of 1½ gallons a minute.
4. to shut off the water in case the proper water level is reached before the timer motor shuts off the water inlet valve
5. a shaded-pole, variable-speed, reversible motor
6. It is mechanically disconnected and does not move.
7. The spray-arm dishwasher has a separate motor for each of two pumps, a recirculating pump and a drain pump, and a spray arm in place of the main motor impeller.
8. The recoil action of the water ejected from the nozzles drives the spray-arm shaft to rotate at high speed.
9. A coarse-screen basket is used for larger particles, and a fine-screen basket is used for smaller particles.
10. by a 110-volt, three-wire, single-phase, alternating current rated at from 12 to 15 amperes
11. supplying auxiliary heat for the wash and rinse water and as a heat source in the drying cycle
12. The pump is mounted directly on the drive motor shaft, with no gear train or drive belt. Inside the pump, a series of flapper valves control whether the pump should drain or idle.

Exercise K-4

Electric Disposers

---

1. grinding or wearing away
2. small projections or lugs
3. (1) continuous-feed
   (2) batch-feed

4. after the cold water and the switch are turned on
5. a rubber baffle inserted in the opening
6. They are placed in the disposer first, before locking a cover, turning on the water, and turning a locking lid.
7. safety
8. the grinding chamber, to see that foreign objects have not accidentally fallen into it
9. more expensive models
10. The disposer should be turned on and emptied completely before the dishwasher is operated.
11. a rubber gasket that mounts between the sink opening and the outer rim
12. by partly replacing the lid
13. (1) grinding table
    (2) metal lugs or impellers
    (3) shredding ring
14. the drain chamber below the grinding table
15. fiberglass or polyurethane

Exercise L-1

Natural Gas Use and Safety

---

1. in oil and gas reservoirs in the earth's subsurface
2. by pipelines
3. about 2 percent for home use and 8 percent for commercial use
4. (1) manufactured
   (2) natural
   (3) liquified petroleum
5. air
6. butane
7. the extreme cold and difficulty of transportation
8. the local gas company
9. Kap-Tan
10. the orifice
11. (1) coke oven gas
    (2) carbureted water gas
12. The air in the room can soon become depleted of oxygen.
13. at the first pump station after it leaves the wellhead

Exercise L-2

Gas Ranges

1. It conforms more nearly to the shape of the vessels being heated and gives a better distribution of gas.
2. the valves
3. a tapered plug, a barrel or body, a stop pin, a spring, a tail nut or cap, and an adjustable or fixed orifice hood
4. The orifices occasionally become clogged.
5. a cooking vessel placed on the burner
6. the ignition of the flames on the simmer burner by the flame lighter
7. (1) top lighters
   (2) automatic lighters
8. pressure variation or internal stoppage
9. The gas-air mixture lights from the pilot, and the flame immediately travels back through the flash tube, thereby igniting the gas mixture.
10. A simple solenoid valve electrically opens and closes a gate to allow gas to flow to the oven burners or stops the gas flow to them.
11. It ensures that no gas can flow to the oven burners unless the pilot flame is lit.
12. to turn the current on and off
13. You must remove the nut and replace the graphite packing.

Exercise L-3

Gas Dryers

1. about 50 rpm
2. a safety switch for the dryer
3. to exhaust moisture-laden air and exhaust gases from the dryer to the outside
4. usually ¼ to ⅓ hp, 115 volts, 60 hertz, split-phase, and set at about 1,725 rpm
5. a thermocouple with enough current to hold the plunger of a solenoid valve in open position
6. a centrifugal switch on the motor housing
7. by a spring-wound clock or an electric motor
8. to interrupt the current to the heater if the temperature of the heater housing exceeds a preset limit
9. in series with the initiator mechanism
10. four

Exercise L-4

Gas Water Heaters

---

1. because of the improper method of connecting the water heater to the storage tank
2. (1) automatic storage
   (2) automatic instantaneous
3. where heavy usage of hot water makes it essential to have enough water available on demand
4. because it can never burn more than a certain amount of gas, depending on how the thermostat is regulated
5. They do not store any heated water. They heat the water directly on demand.
6. to ignite the burner and to heat the thermocouple
7. to ensure effective burner ignition without extinguishing the pilot flame
8. An electric current is produced, which energizes the coil on the core and produces a miniature magnet.
9. An electric current is produced.

Answers to Assignment Tests

Test A-1
Using This Manual
1. student's manual
2. objectives
3. exercise
4. objectives
5. c. multiple-choice.

Test A-2
Occupational Outlook for Appliance Repairers
1. on-the-job
2. portable
3. increase
4. customers' homes

Test B-1
General Hand Tool Safety
1. prying
2. handle
3. energized
4. goggles
5. slot

Test B-2
Working Safely with Electrical Equipment
1. useful / dangerous
2. safety-conscious
3. respect
4. b. turn the power off.
5. rubber / conductor

Test B-3
First Aid for Electrical Shock
1. carelessness / faulty
2. fatal
3. the power off
4. foreign matter
5. artificial respiration

Test B-4
First Aid for Accidental Injuries
1. infection
2. second
3. doctor / pressure
4. shock
5. sterile

Test C-1
Cutting and Driving Tools
1. left
2. handle
3. letters
4. rivets
5. tip
6. square

Test C-2
Pliers, Wrenches, Vises, and Clamps
1. Pliers
2. combination
3. adjustable
4. C-clamp

Test D-1
Portable Drills
1. ½-inch drill
2. geared
3. prick
4. goggles

Test D-2
Drill Presses
1. depth
2. feed
3. Large
4. adjustments

Test D-3
Grinders
1. vitrified
2. flanges
3. dressed
4. dampness
5. one-third

Test E-1
Magnetism
1. one
2. natural
3. attract / repel
4. magnetic field
5. magnetic
6. retentivity

Test E-2
Electricity
1. positive / negative
2. Like / unlike
3. electron
4. valence electron
5. electromotive force

Test E-3
Electromagnetism
1. electromagnet
2. solenoid
3. core
4. magnetomotive
5. magnetic

Test E-4
Units of Electrical Measurement
1. volts
2. negative
3. amperes
4. P/I

Test F-1
Switches
1. electricity
2. single-throw
3. continuity
4. rotary

Test F-2
Timers and Solenoids
1. contacts
2. sandpaper
3. coil
4. relay
5. grounded

Test G-1
The Generation of Alternating Current
1. generator
2. turns
3. cycles per second
4. effective
5. time

Test G-2
Transformers
1. voltage
2. primary
3. eddy currents
4. step-up
5. Autotransformers

Test G-3
Theory of Electric Motors
1. electrical / mechanical
2. turning
3. applied emf
4. revolving (rotating)
5. slip

Test H-1
Inductance and Its Reactance to Alternating Current
1. henry
2. current
3. $L_T = L_1 + L_2$
4. Maximum

Test H-2
Capacitance and Its Reactance to Alternating Current
1. farad (C)
2. dielectric
3. area / distance
4. Capacitive reactance

Test H-3
Alternating-Current Principles
1. Z / ohms
2. Power factor
3. wattmeter / voltmeter
4. 90

Test I-1
Measuring and Test Equipment
1. parallel
2. series
3. multiplier
4. circuit / capacitors
5. moving coil

Test J-1
Heating Effects
1. resistance
2. joule
3. Btu
4. current

Test J-2
Lighting Effects
1. incandescent
2. cathode
3. heat
4. fluorescent
5. panelescent

Test J-3
Incandescent Lighting
1. percentage
2. Candlepower
3. meter
4. lumen
5. frosting

Test J-4
Fluorescent Lighting
1. Operating
2. resistive
3. voltage
4. gas vapor

Test K-1
Electric Ranges
1. tubular
2. bimetal
3. thermostat
4. broil / bake
5. timer
6. Circuit breakers

Test K-2
Electric Clothes Washers
1. automatic
2. gear train
3. mechanical
4. drive pulley
5. discharge impeller

Test K-3
Electric Dishwashers
1. impeller / spray-arm
2. pressure switch
3. motor / spray arm
4. 12 / 15
5. drive motor

Test K-4
Electric Disposers
1. Grinding
2. batch-feed
3. baffle
4. safety
5. endbell

Test L-1
Natural Gas Use and Safety
1. pipelines
2. Air
3. Kap-Tan
4. orifice
5. liquefied

Test L-2
Gas Ranges
1. valves
2. lighter
3. pressure
4. pilot
5. graphite

Test L-3
Gas Dryers
1. safety
2. overheating
3. centrifugal
4. four

Test L-4
Gas Water Heaters
1. storage
2. demand
3. thermocouple
4. ignition

Assignment Tests, Progress Record, and Work Sheets

---

for

Major Appliance Repairer

For Your Convenience . . .

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- Instructors who do not want to reproduce the material can purchase separate sets of just this section from Extension Instruction and Materials Center, The University of Texas at Austin, P. O. Box 7218, Austin, Texas 78712.
- Each assignment test is based on a specific assignment.
- The thirty-eight work sheets are provided for use as weekly logs if the instructor desires. On each sheet is a listing of the contents of the student's manual, for coordinating assignments with work experience.

Test A-1

Using This Manual

1. A _____ _____ is designed to present technical instructions, procedures, and illustrations to the student.

2. The assignment _____ should be studied before reading the information part of the assignment.

3. All assignment _____ answers should be written in the form of complete sentences.

4. It is assumed that the assignment _____ have been met when the exercise questions have been answered correctly.

5. Assignment test questions in this manual are either fill-in-the-blank or—
   a. true-false.
   b. matching.
   c. multiple-choice.
   d. essay.

Test A-2

Occupational Outlook for Appliance Repairers

1. Most appliance repairers acquire their skill through _____ training.

2. The two fields of appliance repair are _____ appliances and major appliances.

3. The future outlook for appliance repairers is an _____ in demand.

4. Major appliances are usually repaired in _____ _____.

Test B-1

General Hand Tool Safety

1. Using a file for _____ operations may cause injury from flying pieces of metal.

2. Pass edged or pointed tools to another person _____ first to avoid accidents.

3. Metal rulers or measuring tapes and screwdrivers should not be used around _____ circuits or equipment.

4. Wear _____ when using a grinding wheel.

5. Always use a screwdriver that fits the _____ in the screw.

Test B-2
Working Safely with Electrical Equipment

1. Electronic equipment can be some of the most _____ and _____ equipment in the shop or on the job.

2. It is very important that you acquire a _____ attitude.

3. You should never lose your _____ for the danger potential of electricity.

4. When working on lighting circuits, you should—
   a. leave the power on.
   b. turn the power off.
   c. work alone.
   d. remove the fuse.

5. If you must work on a live circuit, you should have someone with you, stand on a dry _____ mat, and touch only one _____ at a time.

Test B-3

First Aid for Electrical Shock

1. Accidental electrocutions are caused by _____ _____, misuse of electrical equipment, and _____ wiring.

2. Slight shocks can be _____.

3. If a person comes in contact with a live wire and cannot get loose, you should quickly turn _____ _____ _____.

4. After the victim has been removed from the live circuit, you should check the mouth for _____ _____.

5. If breathing has stopped, immediately start giving _____ _____.

Test B-4

First Aid for Accidental Injuries

1. A slight injury can result in a serious _____.
2. Blisters on the skin are a sign of a _____-degree burn.
3. In case of severe bleeding from a vein, call a _____ at once, and apply a _____ bandage.
4. Cold, clammy skin, a weak pulse, and irregular breathing are all symptoms of _____.
5. To give first aid for a compound fracture, apply a _____ dressing and then splints.

Test C-1

Cutting and Driving Tools

1. If you need to cut a right-hand curve with aviation snips, the upper blade must be on your _____.

2. Always use a _____ on a file during filing operations.

3. Twist drill bits are sized by numbers, _____, fractional inch, or the metric system.

4. The peen of a ball-peen hammer is used to flatten the ends of _____.

5. Screwdrivers are classified according to the type of _____.

6. A heavy-duty screwdriver has a _____ shank.

Test C-2

Pliers, Wrenches, Vises, and Clamps

---

1. _____ cause the most abuse of all hand tools.

2. A wrench with one open end and one box end is called a half-and-half wrench or a _____ wrench.

3. An _____ wrench should not be used if an open end or box wrench of the proper size is available.

4. A _____ has a flat pad on one clamping surface and a screw pad on the other.

Test D-1
Portable Drills

---

1. The _____ drill requires two-handed control to keep the drill from twisting in the operator's hands.

2. A _____ chuck requires the use of a special key to open and close each of the three jaws at the same time.

3. A _____ punch should be used to start a hole or center a drill bit.

4. Always wear _____ when grinding with a drill.

Test D-2
Drill Presses

1. The _____ gauge indicates the limits to which the spindle will travel downward.

2. When drilling, reduce the _____ pressure near the bottom of the hole.

3. _____ drills should be run at slower speeds.

4. Unplug the electrical cord when _____ are being done to the drill presses.

Test D-3
Grinders

1. The _____ bond is adapted to the widest scope of grinding.

2. The metal washers on each side of the grinding wheel are called _____.

3. If a grinding wheel is out of balance, it should be _____.

4. Conditions such as _____ or extreme temperatures may harm grinding wheels.

5. Mounting washers or flanges should be at least _____ the wheel diameter.

Test E-1
Magnetism

1. A magnet has _____ pairs of poles.

2. Magnetite is an unrefined product of nature and is a _____ magnet.

3. Unlike poles _____ one another, and like poles _____ one another.

4. Iron filings have been used in experiments to represent the _____ _____ about a magnet.

5. Iron and steel are examples of _____ substances.

6. The ability of a material to retain its magnetism is called _____.

Test E-2
Electricity

1. The two kinds of electricity are _____ and _____.

2. _____ charges repel each other, and _____ charges attract each other.

3. The elemental unit of electricity is the charge on the _____.

4. Elements that have only one _____ _____ are the best electrical conductors.

5. The force that causes electrons to flow is called _____ _____.

Test E-3
Electromagnetism

1. If a coil is wound on a core of magnetic material, it is a/an _____.

2. A _____ is a coil of wire that has considerable length as compared with its diameter.

3. Soft iron or soft steel is generally used as the _____ for an electromagnet.

4. A force known as the _____ force is required to produce a magnetic flux.

5. A moving electric field creates a _____ field.

Test E-4

Units of Electrical Measurement

---

1. Electromotive force is measured in _____.

2. Electrons have _____ charges.

3. The rate or intensity of current flow is measured in _____.

4. The electrical power law formula for volts is E = _____.

Test F-1
Switches

1. The primary function of switches is to start and stop _____ from flowing in each circuit.

2. In a single-pole, _____ switch, only one wire is connected or disconnected by the switch.

3. An ohmmeter can be used to check the _____ across a switch.

4. A three-way lamp uses a _____ switch with two conductors.

Test F-2

Timers and Solenoids

1. The most common fault in the timer is a pair of _____ that are welded shut.

2. If contacts are stuck together, they can be cleaned with _____.

3. A solenoid consists of a _____ and a soft iron bar.

4. A _____ is a solenoid that controls a high current or voltage.

5. The most common trouble in a solenoid is an open coil or a _____ coil.

Test G-1

The Generation of Alternating Current

1. The most common source of electrical energy is the _____.
2. The magnitude of the induced emf is affected by the number of _____ in the conductor.
3. Frequency is measured in _____ _____ _____.
4. Electrical meters are calibrated to read _____ values.
5. Phase difference is the difference in _____ between any two cycles.

Test G-2
Transformers

---

1. A transformer is a device by which the _____ of an alternating-current system may be changed.

2. The coil connected to the source of power is the _____ winding, and the coil connected to the load is the _____ winding.

3. If the transformer core is made up of thin strips of metal with insulating material between them, the _____ _____ cannot cross through the insulation.

4. A _____ transformer has more turns in the secondary coil than in the primary coil.

5. _____ are used in some motor control circuits to provide reduced voltage starting of large AC motors.

Test G-3

Theory of Electric Motors

---

1. The purpose of the electric motor is to change _____ energy into _____ energy.

2. Torque is the _____ force exerted in a magnetic field.

3. As the motor speed increases, the back emf increases, until it is almost equal to the _____ _____.

4. The operating principle of the induction motor depends on a _____ magnetic field to produce torque.

5. The difference in speed between the rotor and the rotating field is called _____ and is expressed as a percentage of the synchronous speed.

Test H-1

Inductance and Its Reactance to Alternating Current

---

1. The unit of measurement of inductance is the _____.

2. Inductance is that property of an electrical circuit that tends to prevent a change in _____.

3. The formula for calculating the total inductance of two shielded inductors in series is _____.

4. _____ power is used in a pure resistive AC circuit.

Test H-2

Capacitance and Its Reactance to Alternating Current

---

1. The unit (and symbol) used for capacity measurement is the _____.

2. The insulation between the plates of a capacitor is called the _____.

3. The capacity of a capacitor is affected by (1) the _____ of plates, (2) the _____ between plates, and (3) dielectric materials.

4. _____ _____ is that property that opposes any change in the magnitude of voltage.

Test H-3

Alternating-Current Principles

1. Impedance is represented by the symbol _____ and is measured in _____.

2. _____ _____ is the ratio of true power to apparent power.

3. True power is measured with a _____, and apparent power is the product of the readings of a _____ and an ammeter.

4. The total reactance value cannot be added directly to the resistance value because they are _____ degrees out of phase with each other.

Test I-1

Measuring and Test Equipment

1. Voltmeters are always connected in _____ in relation to the load.

2. Ammeters are always connected in _____ in relation to the load.

3. The range of a voltmeter may be exceeded by connecting a high-resistance _____ in series with the meter movement.

4. Before using an ohmmeter, the power must be disconnected from the _____, and all _____ must be discharged.

5. In permanent-magnet meters, one field is supplied by a permanent magnet, and the other by a _____ _____.

Test J-1

Heating Effects

1. The methods of producing heat from electricity are _____, induction, and dielectric.

2. A _____ is a unit of work equal to one watt-second.

3. Heat is measured in calories or _____.

4. The heat generated in a conductor is proportional to the time, the resistance, and the square of the _____.

Test J-2

Lighting Effects

1. The _____ lamp is the most commonly used lamp today.

2. Cold _____ lights are used where extremely long life is a major consideration.

3. The primary disadvantage of incandescent lamps is that most of the electricity consumed is changed into _____.

4. The _____ lamp produces about three times as much light as the incandescent lamp for the same amount of electricity.

5. The night light is a common type of the _____ lamp.

Test J-3

Incandescent Lighting

1. Reflectance is the _____ of light reflected from a surface.

2. _____ identifies the intensity of a light source.

3. A light _____ measures the amount of light falling on a given point.

4. The _____ is the unit for measuring light quantity.

5. Undesirable glare of a light bulb is reduced by _____ the inside of the bulb.

Test J-4

Fluorescent Lighting

1. _____ conditions influence the life of a fluorescent lamp.

2. The thermal starter includes a _____ element that is heated by current flow.

3. The purpose of a ballast or a ballast transformer in a fluorescent lamp is to eliminate flicker and to produce a surge in starting _____.

4. Mercury lamps operate by producing light by passing a current through a _____ _____ under pressure.

Test K-1
Electric Ranges

1. The types of surface units are (1) the wire-coil type and (2) _____ units.

2. A _____ switch is used to achieve variation in heat for surface units.

3. Oven temperature is adjusted by a selector switch and a _____.

4. Tubular oven units include a _____ unit at the top with two coils, and a _____ unit at the bottom with one coil.

5. The _____ is powered by a synchronous motor.

6. _____ _____ are installed on electric ranges to eliminate the nuisance of blown branch line fuses.

Test K-2
Electric Clothes Washers

---

1. The two main types of washers are the _____ type and the conventional type.

2. Agitators are driven by either a _____ _____ or a clutch arrangement.

3. The three major assemblies of washers are the _____ system, the water system, and the electrical system.

4. In both the agitator and tumbler washers, the cylinder basket is driven by a V-belt riding on a _____ _____.

5. Water is ejected from a tub by the _____ _____ of the water pump.

Test K-3
Electric Dishwashers

1. The two general types of dishwashers are the _____ dishwasher and the _____ dishwasher.

2. A _____ _____ shuts off the water in case the proper water level is reached before the timer motor shuts off the water inlet valve.

3. The spray-arm dishwasher has a separate _____ for each of two pumps and a _____ _____ in place of the main motor impeller.

4. Dishwashers run on alternating current rated at from _____ to _____ amperes.

5. The pump is mounted directly on the _____ _____ shaft.

Test K-4

Electric Disposers

---

1. _____ or wearing away action takes place in a disposer.

2. Garbage disposers are either continuous-feed or _____.

3. A rubber _____ inserted in the opening keeps water and waste from being thrown into the sink from the grinding chamber.

4. The greatest advantage of the batch-feed disposer is _____.

5. The lower _____ forms the drain chamber below the grinding table.

Test L-1

Natural Gas Use and Safety

1. Natural gas is transported by _____.
2. _____ is mixed with gas during the burning process.
3. _____ is added to give an odor to natural gas.
4. The _____ of a gas burner should be cleaned periodically.
5. The three main types of gases used in heating appliances are manufactured, natural, and _____ petroleum.

Test L-2
Gas Ranges

---

1. The _____ control the gas supply to the burners.

2. The simmer flame adjustment is governed by the ignition of the flames on the simmer burner by the flame _____.

3. Pilots are particularly sensitive to _____ variation or internal stoppage.

4. The flame switch assures that no gas can flow to the oven burners unless the _____ flame is lit.

5. If there is a leak around the lighter valve stem, you must remove the nut and replace the _____ packing.

Test L-3
Gas Dryers

1. The door switch on a dryer functions as a _____ switch.

2. High-limit thermostats protect against _____.

3. A _____ switch on the motor housing closes the circuit to the main-burner solenoid when the motor has reached about 1,400 rpm.

4. No more than _____ right-angle turns should be made in an exhaust pipe.

Test L-4
Gas Water Heaters

1. The two types of automatic gas water heaters are automatic _____ and automatic instantaneous.

2. Automatic instantaneous gas water heaters heat the water directly on _____.

3. The pilot in a gas water heater ignites the burner and heats the _____.

4. A careful pilot adjustment is necessary to ensure effective burner _____ without extinguishing the pilot flame.

PROGRESS RECORD
for
MAJOR APPLIANCE REPAIRER

Training Station:_____ Student:_____

JOB PROGRESS RECORD

CLASS PROGRESS RECORD

TYPICAL JOBS OR OPERATIONS	SEMESTERS				RELATED STUDY TOPICS	CODE	GRADE
	1st	2nd	3rd	4th			
					A. Introduction to Major Appliance Repair		
					Using This Manual	A-1	
Study various careers.					Occupational Outlook for Appliance Repairers	A-2	
					B. Safety		
Use hand tools safely.					General Hand Tool Safety	B-1	
Use care with electrical equipment.					Working Safely with Electrical Equipment	B-2	
Study procedures to use for electrical shock.					First Aid for Electrical Shock	B-3	
Study procedures to use for accidental injuries.					First Aid for Accidental Injuries	B-4	
					C. Hand Tools for Appliance Repair		
Use snips, hacksaws, files, drills, hammers, and screwdrivers.					Cutting and Driving Tools	C-1	
Use pliers, wrenches, clamps, and vises.					Pliers, Wrenches, Clamps, and Vises	C-2	

JOB PROGRESS RECORD					CLASS PROGRESS RECORD		
TYPICAL JOBS OR OPERATIONS	SEMESTERS				RELATED STUDY TOPICS	Grade	Test Grade
	1st	2nd	3rd	4th			
					D. Power Tools for Appliance Repair		
Use portable drills and drill bits to repair appliances.					Portable Drills	D-1	
Use drill press to drill and ream holes in assemblies.					Drill Presses	D-2	
Use grinders to sharpen bits and grind off edges, etc.					Grinders	D-3	
					E. Introduction to Electrical and Magnetic Fundamentals		
Study the theory of magnetism and how it relates to appliances.					Magnetism	E-1	
Study the theory of electricity and how it is used with appliances.					Electricity	E-2	
Study the theory of electromagnetism and how it applies.					Electromagnetism	E-3	
Study how electrical measurement is applied to appliances.					Units of Electrical Measurement	E-4	
					F. Controls		
Install and repair appliance and wall switches.					Switches	F-1	
Repair and install timers and solenoids.					Timers and Solenoids	F-2	

JOB PROGRESS RECORD

CLASS PROGRESS RECORD

TYPICAL JOBS OR OPERATIONS	SEMESTERS				RELATED STUDY TOPICS	Grade	Test Grade
	1st	2nd	3rd	4th			
					G. Electromagnetic Fundamentals of AC Generators, Transformers, and Motors		
Study how an alternating current is generated.					The Generation of Alternating Current	G-1	
Study and install various transformers.					Transformers	G-2	
Study how electric motors operate.					Theory of Electric Motors	G-3	
					H. Theory and Measurement of Alternating Current		
Study how inductance reacts to an alternating current.					Inductance and Its Reactance to Alternating Current	H-1	
Study how capacitance reacts to an alternating current.					Capacitance and Its Reactance to Alternating Current	H-2	
Study the principles of alternating current.					Alternating-Current Principles	H-3	
					I. Electrical Meters and Test Equipment		
Study and use various measuring and test equipment.					Measuring and Test Equipment	I-1	
					J. Heating and Lighting		
Study heating effects during use of various appliances.					Heating Effects	J-1	

JOB PROGRESS RECORD					CLASS PROGRESS RECORD		
TYPICAL JOBS OR OPERATIONS	SEMESTERS				RELATED STUDY TOPICS	Grade	Test Grade
	1st	2nd	3rd	4th			
Study lighting effects and install in appliances.					Lighting Effects	J-2	
Study incandescent bulbs and lighting and install in appliances.					Incandescent Lighting	J-3	
Study and install fluorescent bulbs in appliances.					Fluorescent Lighting	J-4	
					K. Electric Appliances		
Repair various components of electric ranges.					Electric Ranges	K-1	
Repair various components of electric clothes washers.					Electric Clothes Washers	K-2	
Repair various components of electric dishwashers.					Electric Dishwashers	K-3	
Repair various components of electric disposers.					Electric Disposers	K-4	
					L. Gas Appliances		
Study natural gas use and safety.					Natural Gas Use and Safety	L-1	
Repair various components of gas ranges.					Gas Ranges	L-2	
Repair various components of gas dryers.					Gas Dryers	L-3	
Repair various components of gas water heaters.					Gas Water Heaters	L-4	

CONTENTS OF STUDENT'S MANUAL

Section A. Introduction to Major Appliance Repairer
- A-1: Using This Manual
- A-2: Occupational Outlook for Appliance Repairers

Section B. Safety
- B-1: General Hand Tool Safety
- B-2: Working Safely with Electrical Equipment
- B-3: First Aid for Electrical Shock
- B-4: First Aid for Accidental Injuries

Section C. Hand Tools for Appliance Repair
- C-1: Cutting and Driving Tools
- C-2: Pliers, Wrenches, Clamps, and Vises

Section D. Power Tools for Appliance Repair
- D-1: Portable Drills
- D-2: Drill Presses
- D-3: Grinders

Section E. Introduction to Electrical and Magnetic Fundamentals
- E-1: Magnetism
- E-2: Electricity
- E-3: Electromagnetism
- E-4: Units of Electrical Measurement

Section F. Controls
- F-1: Switches
- F-2: Timers and Solenoids

Section G. Electromagnetic Fundamentals of AC Generators, Transformers, and Motors
- G-1: The Generation of Alternating Current
- G-2: Transformers
- G-3: Theory of Electric Motors

Section H. Theory and Measurement of Alternating Current
- H-1: Inductance and Its Reactance to Alternating Current
- H-2: Capacitance and Its Reactance to Alternating Current
- H-3: Alternating-Current Principles

Section I. Electrical Meters and Test Equipment
- I-1: Measuring and Test Equipment

Section J. Heating and Lighting
- J-1: Heating Effects
- J-2: Lighting Effects
- J-3: Incandescent Lighting
- J-4: Fluorescent Lighting

Section K. Electric Appliances
- K-1: Electric Ranges
- K-2: Electric Clothes Washers
- K-3: Electric Dishwashers
- K-4: Electric Disposers

Section L. Gas Appliances
- L-1: Natural Gas Use and Safety
- L-2: Gas Ranges
- L-3: Gas Dryers
- L-4: Gas Water Heaters

WORK SHEET

FOR COORDINATING JOBS WITH RELATED INSTRUCTION USING *MAJOR APPLIANCE REPAIRER*

This form is for your convenience in planning and keeping records of training. Contents of the student's manual are at the left. The columns below provide space for listing job experiences for the individual student and assignment numbers and other references related to each job. Blanks are large and divided by days so the teacher and student can list other information that might be useful in a weekly log.

Student _____

Training Station _____

JOB EXPERIENCES	RELATED INSTRUCTION
Monday Work Hrs:	
Tuesday Work Hrs:	
Wednesday Work Hrs:	
Thursday Work Hrs:	
Friday Work Hrs:	